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Frequency Discriminator/Phase Detector

The problem:

Frequency acquisition in phase-locked loops often takes too much time. One common circuit used in the reduction of the acquisition time is an auxiliary frequency discriminator. The discriminator, however, complicates the loop circuit.

The solution:

A circuit providing the dual function of frequency discriminator/phase detector reduces frequency acquisition time without adding to circuit complexity.

How it's done:

Two frequency discriminator/phase detector circuits, as shown in Figures 1 and 2, were developed and evaluated. Basically both circuits accept sine wave inputs, shape them, and control two flip-flops (FF1 and FF2). In the circuit of Figure 1, the input frequency f_0 is higher than input frequency f_1 , so that Q (FF1) is false most of the time while \bar{Q} (FF2) is true. These two flip-flop outputs are differenced, using an operational amplifier to produce a dc signal output that is proportional to the input frequency difference.

The frequency discriminator characteristic is the same for both circuits. Both frequency discriminators are effective two decades above and below the center frequency. In addition, they are broadband and can be

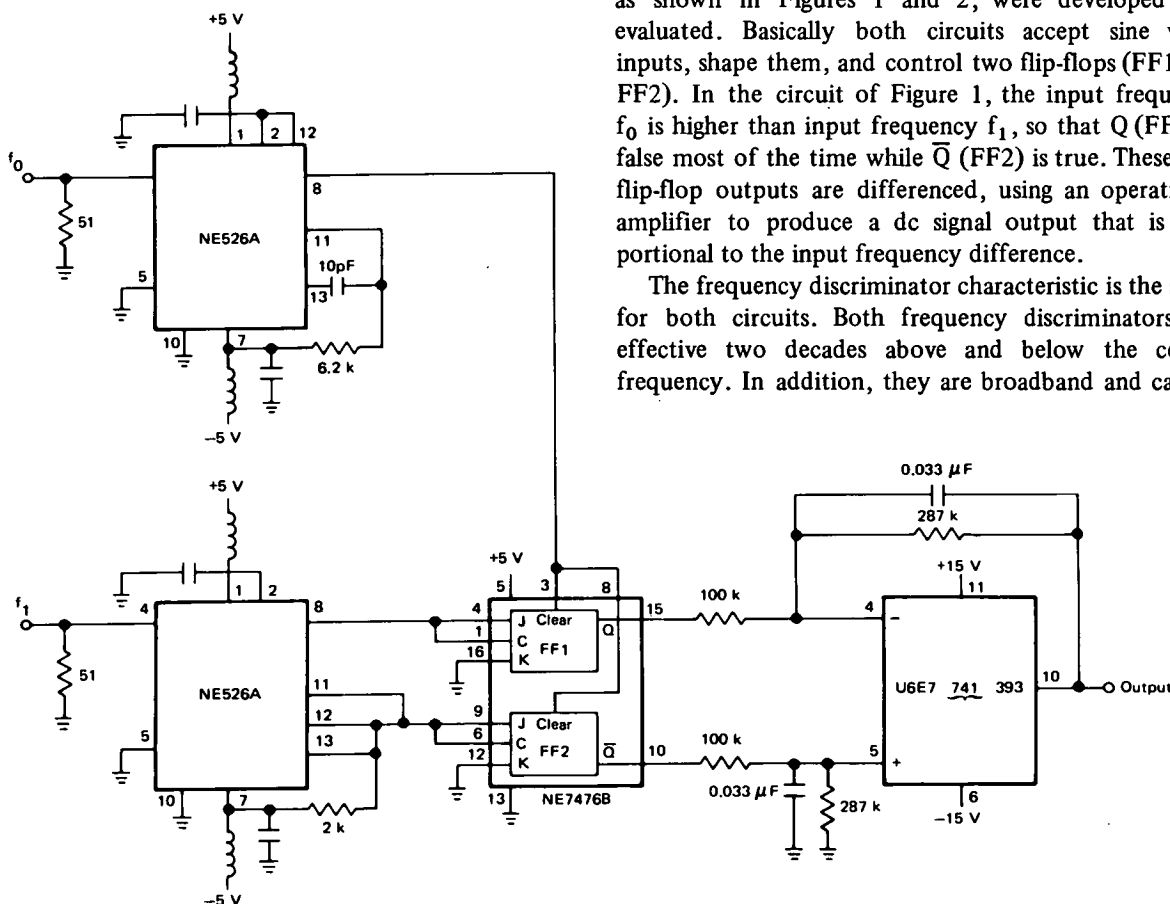


Figure 1. Frequency Discriminator/Phase Detector With Half the Linear Range of Circuit Shown in Figure 2.

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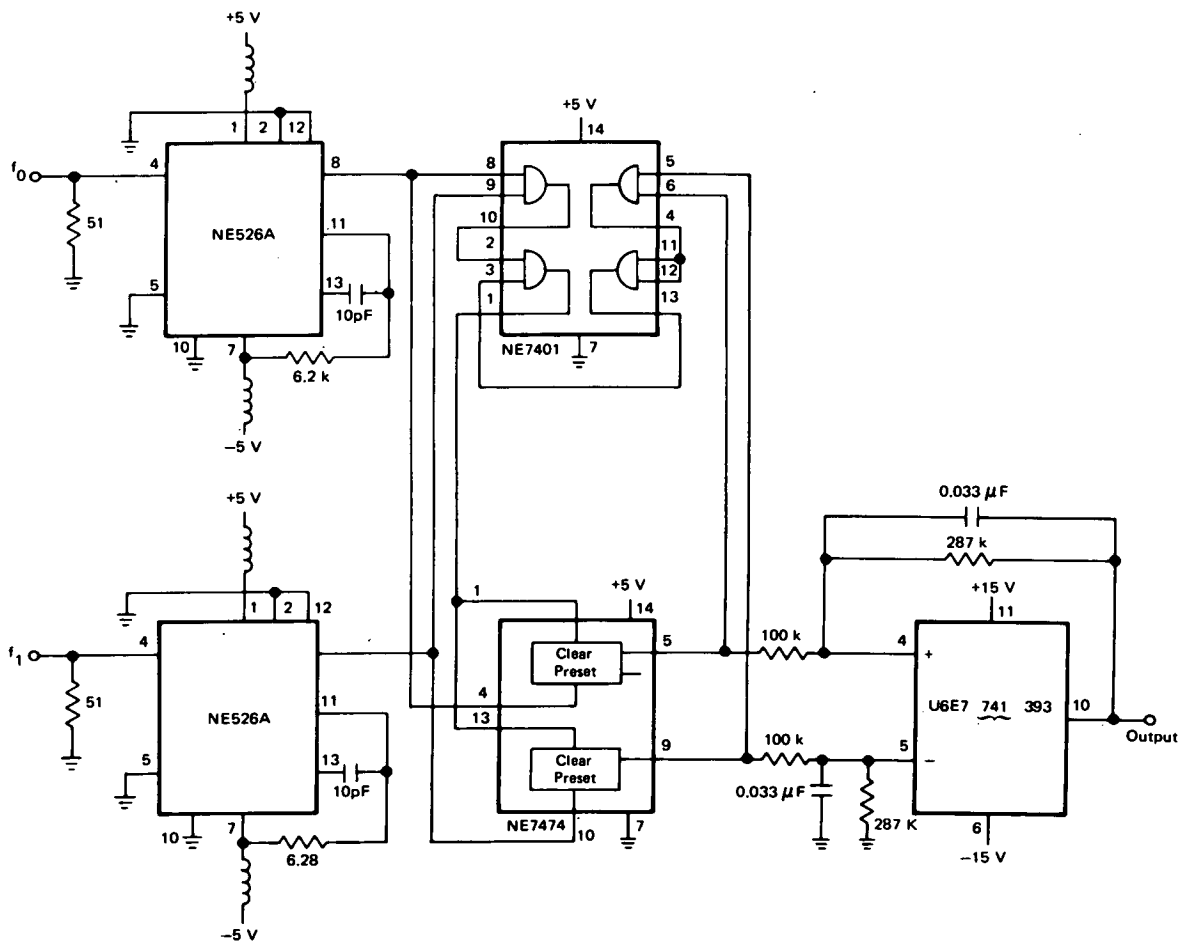


Figure 2. Frequency Discriminator/Phase Detector.

used for reference frequencies from 1 kHz to approximately 3 MHz. Further bandwidth extension is possible by changing the input differentiator circuit.

When the two signals are of the same frequency, the circuits perform as phase detectors. The circuit shown in Figure 1 has the same detector gain as the one shown in Figure 2 but only half the linear range. The former has a 180° phase ambiguity when it is used in a phase-locked loop. In each case the signal input power can be as low as -20 dBm with a negligible reduction in output performance.

Note:

Requests for further information may be directed to:
 Technology Utilization Officer
 NASA Pasadena Office
 4800 Oak Grove Drive
 Pasadena, California 91103
 Reference: TSP74-10098

Patent status:

Title to this invention, covered by U.S. Patent No. 3,750,035 has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to the California Institute of Technology, Pasadena, California 91109.

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